Working Paper

REMOTELY PILOTED VEHICLE (AQUILA) FORCE DEVELOPMENT TEST AND EXPERIMENTATION .

(FDTE): ARMY RESEARCH INSTITUTE FORT HOOD FIELD UNIT EVALUATION (1987)

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INTRODUCTION

This Working Paper represents the Fort Hood Army Research Institute (ARI) Field Unit contribution to the TRADOC Test and Experimentation Command (TEXCOM) (Provisional) report of the 1987 Remotely Piloted Vehicle (RPV) (Aquila) Force Development Test and Experimentation (FDTE). This report was submitted to TEXCOM on 12 January 1988.

The report is presented in four sections. Section I presents a summary of conflict resolution information gathered from an analysis of video tapes. These analyses are in response to Evaluation Plan Criteria 2.2.1.2.2 ("The GCS crew must identify incomplete mission order request forms and high risk or nonexecutable missions, and resolve conflicts.") Section II presents the results of questionnaires administered after each RPV flight to assess the impact of a fourth crewmember of GCS operations. Section III also addresses the impact of a fourth crewmember on GCS operations but presents data from questionnaires administered at the end of the test. Section IV is a narrative summary of the results.

The purpose of this report was to provide TEXCOM with data that could be integrated with data from other sources in producing a final report. The organization and format of this report reflect that purpose.

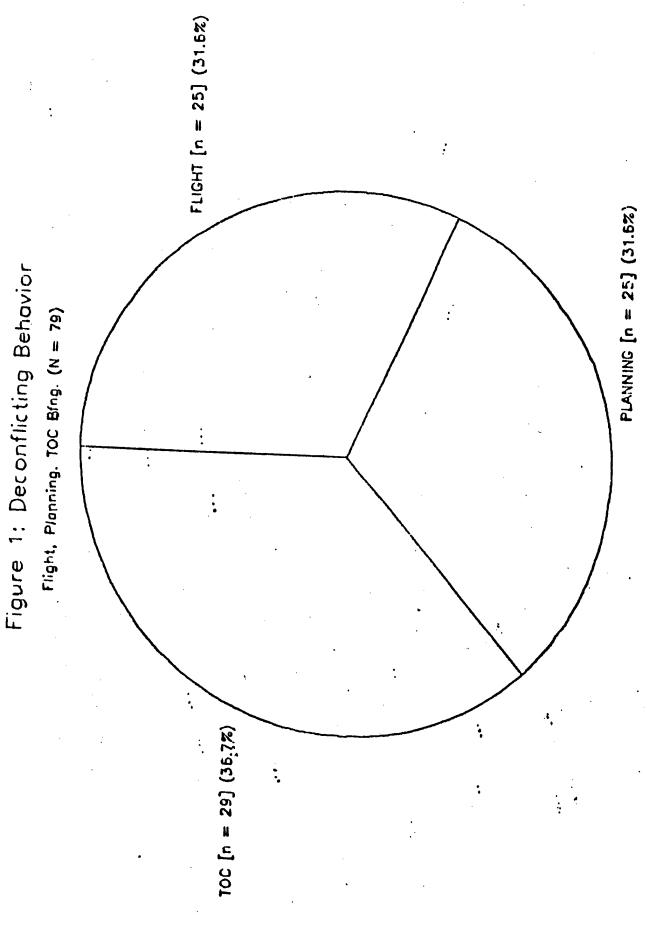
I. GCS Crew-TOC Conflict Resolution

Figures 1 through 4 address Evaluation Plan criterion 2.2.1.2.2, "The GCS crew must identify incomplete mission order request forms and high risk or nonexecutable missions, and resolve conflicts". The videotapes made of a) the MC receiving an RPV mission at TOC, b) crews planning a mission, and c) crews flying a mission, were scored as to the number of times that a GCS crew questioned the TOC as to the feasibility of the mission given to the RPV, and the number of times that the crew explained RPV capabilities to the TOC. On the 20 flights (4 crews executing 5 missions) that were scored, there were a total of 79 such communications. As can be seen in Figure 1, 29 of these occurred during mission briefing at TOC, 25 occurred during mission planning, and 25 occurred during flight. Thus, conflict resolution was fairly evenly spread out over the three phases of mission execution, although 68% of the conflict resolution that occurred did take place prior to mission flight.

Figures 2 through 4 show the proportion of total communications that were devoted to conflict resolution during each of the mission execution phases. As can be seen in Figure 2, conflict resolution is the predominant communications activity during mission briefing at the TOC, making up 88% of the MC-TOC communications in that phase. During mission planning (Figure 3) the total number of conflict resolution communications stays about the same as during mission briefing, although the proportion of conflict resolution events relative to the total number of communications during mission planning falls to about eight percent. Finally, during flight (Figure 4) the absolute number of

conflict resolution events remains about the same as in the previous phases, although as a proportion of the total communications in mission flight it falls to less than 1%.

In summary, then, it appears that crews did engage in conflict resolution during the execution of RPV missions with about two-thirds of such activity occurring prior to mission flight and one-third occurring during mission flight.



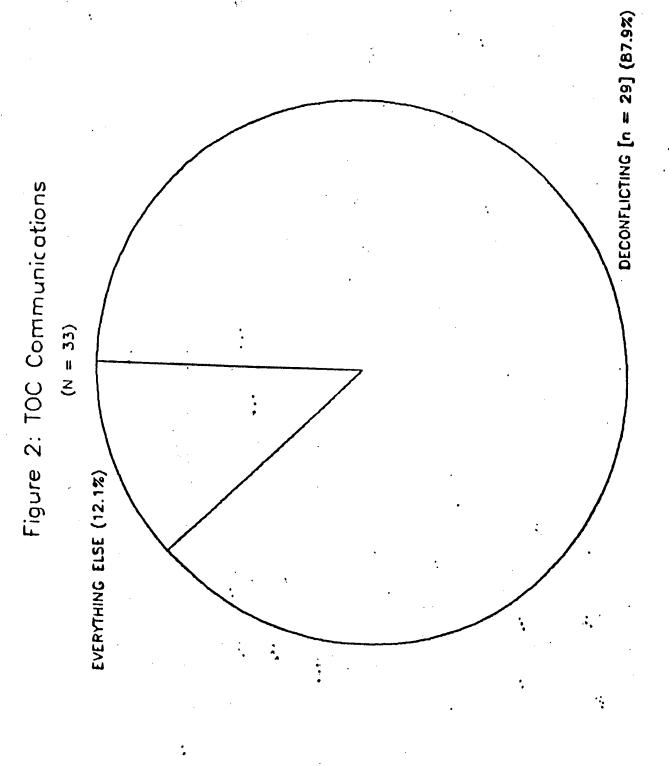
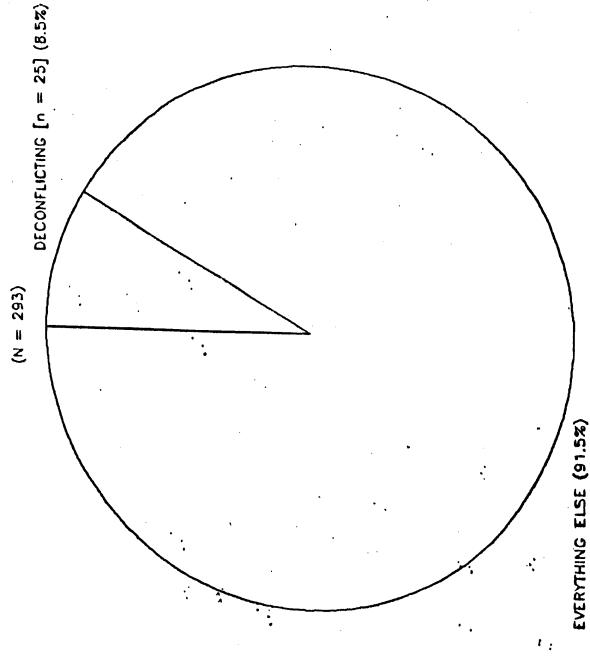
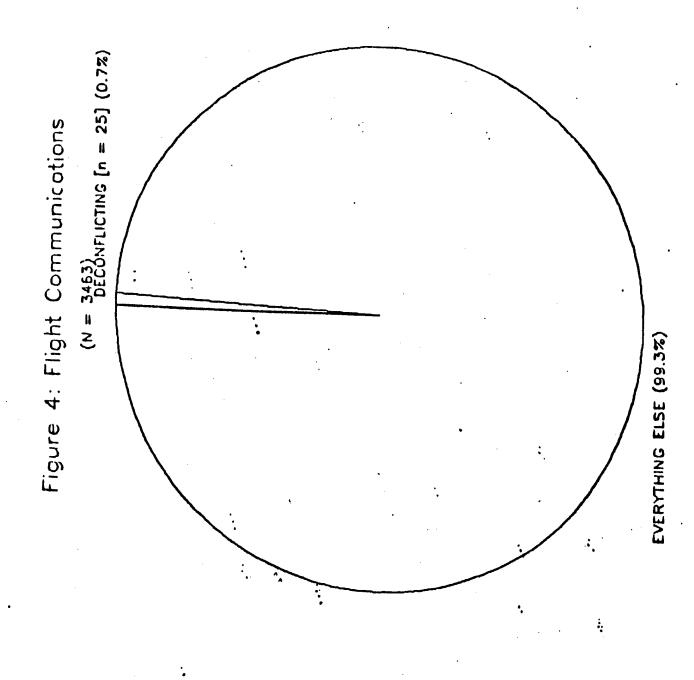


Figure 3: Planning Communications





II: Post-flight Questionnaires

At the end of each flight the four crewmen attended an ARI debriefing and completed the questionnaire found in Appendix A. In all, 92 post-flight questionnaires were completed. The respondents were instructed to complete the questionnaire as it pertained to their latest flight.

Descriptive statistics are shown below, with brief item explanations. (The exact wording of each item is presented in Appendix A.) The data are given for (1) all crew members, then for (2) each position, then for (3) each crew.

ALL CREW MEMBERS

```
Item 1: Did you look for targets?
No = 1     Yes = 91
```

```
Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.4 SD = 0.9
Tech Mean = 3.3 SD = 0.9
AVO Mean = 2.7 SD = 0.9
MPO Mean = 1.6 SD = 1.0
```

- Item 7: Who was unnecessary for target recognition?

 MC = 10 Tech = 39 AVO = 3 MPO = 0 No one = 40
- Item 8: Rank order importance of each crewman for overall mission success.

 (1.0 most important; 4.0 least important)

 MC Mean = 2.4 SD = 1.1

 Tech Mean = 2.9 SD = 1.1

 AVO Mean = 2.2 SD = 1.0

 MPO Mean = 2.4 SD = 1.0
- Item 9: Who was unnecessary for overall mission success?

 MC = 12 Tech = 27 AVO = 0 MPO = 0 No one = 53

- Compare workload of normal flights with latest flight. Item 10: (1.0 not busy at all; 10.0 very busy) Normal Mission Mean = 7.4 SD = 2.0Latest Mission Mean = 4.2 SD = 2.4Item 11: Perform own tasks / Perform other crew members' tasks. (1.0 = Totally own tasks; 10.0 = Totally others tasks) Mean = 2.6 SD = 1.8MISSION COMMANDERS Item 1: Did you look for targets? No = 0Yes = 23Item 2: Who reported the first target detection? MC = 5 Tech = 6 AVO = 6 MPO = 6 No response = 0 Item 3: Who reported most target detections? MC = 3 Tech = 2 AVO = 4 MPO = 14 No response = 0 Item 4: Rank order importance of each crewman for target detection. (1.0 most important; 4.0 least important) MC Mean = 2.7 SD = 1.0Tech Mean = 3.2 SD = 0.9AVO Mean = 2.3 SD = 0.9MPO Mean = 1.7 SD = 1.0Item 5: Who was unnecessary for target detection? MC = 0 Tech = 3 AVO = 0MPO = 0 No one = 20 Item 6: Rank order importance of each crewman for target recognition. (1.0 most important; 4.0 least important) Mean = 1.6 SD = 0.5Tech Mean = 3.1 SD = 0.9
- Item 7: Who was unnecessary for target recognition?
 MC = 0 Tech = 5 AVO = 3 MPO = 0 No one = 15

Mean = 2.9 SD = 0.9

Mean = 2.3 SD = 1.3

AVO

MPO

- Item 8: Rank order importance of each crewman for overall mission success.
 (1.0 most important; 4.0 least important)
 MC Mean = 2.6 SD = 1.2
 Tech Mean = 2.8 SD = 0.9
 AVO Mean = 2.3 SD = 1.1
 MPO Mean = 2.4 SD = 1.0
- Item 9: Who was unnecessary for overall mission success?
 MC = 0 Tech = 0 AVO = 0 MPO = 0 No one = 23

Item 10: Compare workload of normal flights with latest flight.

(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 7.6 SD = 1.6
Latest Mission Mean = 4.5 SD = 2.3

Item 11: Perform own tasks / Perform other crew members' tasks.

(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.1 SD = 1.7

TECHNICIANS

- Item 1: Did you look for targets?
 No = 0 Yes = 23
- Item 2: Who reported the first target detection? $\text{MC} = 3 \quad \text{Tech} = 4 \quad \text{AVO} = 1 \quad \text{MPO} = 14 \quad \text{No response} = 1$
- Item 3: Who reported most target detections?
 MC = 0 Tech = 3 AVO = 2 MPO = 9 No response = 9
- Item 4: Rank order importance of each crewman for target detection.
 (1.0 most important; 4.0 least important)

 MC Mean = 2.4 SD = 0.6

 Tech Mean = 3.9 SD = 0.5

 AVO Mean = 2.4 SD = 0.7

 MPO Mean = 1.1 SD = 0.5
- Item 5: Who was unnecessary for target detection?
 MC = 0 Tech = 15 AVO = 0 MPO = 0 No one = 8
- Item 6: Rank order importance of each crewman for target recognition.
 (1.0 most important; 4.0 least important)

 MC Mean = 2.5 SD = 0.6

 Tech Mean = 3.8 SD = 0.6

 AVO Mean = 2.5 SD = 0.7

 MPO Mean = 1.0 SD = 0.2
- Item 7: Who was unnecessary for target recognition? $\text{MC} = 1 \quad \text{Tech} = 14 \quad \text{AVO} = 0 \quad \text{MPO} = 0 \quad \text{No one} = 8$
- Item 9: Who was unnecessary for overall mission success? MC = 1 Tech = 12 AVO = 0 MPO = 0 No one = 10

- Compare workload of normal flights with latest flight. (1.0 not busy at all; 10.0 very busy) Normal Mission Mean = 6.8 SD = 2.2Latest Mission Mean = 4.5 SD = 2.4 Perform own tasks / Perform other crew members' tasks. Item 11: (1.0 = Totally own tasks; 10.0 = Totally others tasks) Mean = 3.5 SD = 2.2AIR VEHICLE OPERATOR Did you look for targets? No = 1 Yes = 22Item 2: Who reported the first target detection? MC = 2 Tech = 7 AVO = 4 MPO = 9No response = 1 Item 3: Who reported most target detections? MC = 0 Tech = 3 AVO = 4 MPO = 13 No response = 3 Item 4: Rank order importance of each crewman for target detection. (1.0 most important; 4.0 least important) Mean = 3.0 SD = 0.9MC Tech Mean = 3.0 SD = 1.1Mean = 2.7 SD = 0.9AVO MPN Mean = 1.3 SD = 0.6Item 5: Who was unnecessary for target detection? MC = 9 Tech = 8 AVO = 0 MPO = 0 No one = 6 Rank order importance of each crewman for target recognition. Item 6: (1.0 most important; 4.0 least important) MC Mean = 2.7 SD = 1.0Tech Mean = 3.1 SD = 1.0AVO Mean = $2.6 \, \text{SD} = 0.8$ MPO Mean = $1.5 \text{ SD} \approx 0.8$ Item 7: Who was unnecessary for target recognition? MC = 4 Tech = 11 AVO = 0 MPO = 0 No one = 8 Item Rank order importance of each crewman for overall mission success. 8: (1.0 most important; 4.0 least important) MC Mean = 2.7 SD = 1.1Tech Mean = 2.8 SD = 1.3
- Item 9: Who was unnecessary for overall mission success?
 MC = 6 Tech = 8 AVO = 0 MPO = 0 No one = 9

AVO Mean = 2.3 SD = 1.2

Mean = 2.2 SD = 0.7

MPO

```
Item 10:
          Compare workload of normal flights with latest flight.
           (1.0 not busy at all; 10.0 very busy)
          Normal Mission Mean = 7.3
                                        SD = 2.2
           Latest Mission Mean = 3.0
                                        SD = 2.3
Item 11:
          Perform own tasks / Perform other crew members' tasks.
          (1.0 = Totally own tasks; 10.0 = Totally others tasks)
          Mean = 2.8 SD = 1.5
MISSION PAYLOAD OPERATOR
Item 1:
          Did you look for targets?
          No = 0 Yes = 23
Item 2:
          Who reported the first target detection?
          MC = 2 Tech = 6 AVO = 5 MPO = 10
                                                      No response = 0
Item 3:
          Who reported most target detections?
          MC = 1 Tech = 1 AVO = 3 MPO = 15
                                                      No response = 3
          Rank order importance of each crewman for target detection.
Item 4:
           (1.0 most important; 4.0 least important)
               Mean = 2.9 \text{ SD} = 0.8
          Tech Mean = 3.3 SD = 0.9
          AVO
               Mean = 2.6 SD = 0.8
          MPO
                Mean = 1.2 \text{ SD} = 0.5
Item 5:
          Who was unnecessary for target detection?
          MC = 6 Tech = 8 AVO = 0 MPO = 0 No one = 9
Item 6:
          Rank order importance of each crewman for target recognition.
          (1.0 most important; 4.0 least important)
               Mean = 2.5 \text{ SD} = 1.0
          Tech Mean = 3.2 SD = 0.9
          AVO
                Mean = 2.8 \text{ SD} = 1.0
          MPN
                Mean = 1.6 SD = 1.0
Item 7:
          Who was unnecessary for target recognition?
          MC = 5 Tech = 9 AVO = 0 MPO = 0 No one = 9
          Rank order importance of each crewman for overall mission success.
Item 8:
          (1.0 most important; 4.0 least important)
                Mean = 2.3 \text{ SD} = 1.2
          Tech Mean = 3.0 \text{ SD} = 1.3
```

11

MC = 5 Tech = 7 AVO = 0 MPO = 0 No one = 11

Who was unnecessary for overall mission success?

Mean = 2.1 SD = 0.9

Mean = 2.6 SD = 1.0

AVO

MPO

Item 9:

```
Compare workload of normal flights with latest flight.
Item 10:
          (1.0 not busy at all; 10.0 very busy)
          Normal Mission Mean = 7.8 SD = 1.9
          Latest Mission Mean = 4.9
                                        SD = 2.1
          Perform own tasks / Perform other crew members' tasks.
Item 11:
          (1.0 = Totally own tasks; 10.0 = Totally others tasks)
          Mean = 2.1 SD = 1.7
CREW A
Item 1:
          Did you look for targets?
          No = 0 Yes = 24
Item 2:
          Who reported the first target detection?
          MC = 1 Tech = 4 AVO = 8 MPO = 11
                                                    No response = 0
          Who reported most target detections?
Item 3:
          MC = 1 Tech = 1 AVO = 10 MPO = 9 No response = 3
          Rank order importance of each crewman for target detection.
Item 4:
           (1.0 most important; 4.0 least important)
                Mean = 2.7 SD = 0.9
          MC
          Tech Mean = 3.6 SD = 0.9
           AVO Mean = 2.0 \text{ SD} = 0.8
               Mean = 1.8 \text{ SD} = 1.0
          MPO
Item 5:
          Who was unnecessary for target detection?
          MC = 4 Tech = 13 AVO = 0
                                           MPO = 0 No one = 7
           Rank order importance of each crewman for target recognition.
Item 6:
           (1.0 most important; 4.0 least important)
                Mean = 2.2 \text{ SD} = 1.0
           Tech Mean = 3.2 SD = 1.0
                Mean = 2.3 \text{ SD} = 0.8
           AVO
                Mean = 2.4 \text{ SD} = 1.3
           MPO
           Who was unnecessary for target recognition?
Item 7:
           MC = 3 Tech = 13 AVO = 0 MPO = 0 No one = 8
Item 8:
           Rank order importance of each crewman for overall mission success.
           (1.0 most important; 4.0 least important)
                Mean = 2.0 \text{ SD} = 0.9
           Tech Mean = 3.5 SD = 0.8
           AVO
                Mean = 1.7 SD = 0.8
           MPO
                Mean = 2.7 SD = 1.0
```

MC = 1 Tech = 9 AVO = 0 MPO = 0 No one = 14

Who was unnecessary for overall mission success?

Item 9:

```
Compare workload of normal flights with latest flight.
Item 10:
          (1.0 not busy at all; 10.0 very busy)
          Normal Mission Mean = 6.2 SD = 2.4
                           Mean = 2.9
                                        SD = 1.8
          Latest Mission
          Perform own tasks / Perform other crew members' tasks.
Item 11:
          (1.0 = Totally own tasks; 10.0 = Totally others tasks)
          Mean = 2.6 SD = 2.1
CREW B
          Did you look for targets?
Item 1:
          No = 1 Yes = 23
          Who reported the first target detection?
Item 2:
          MC = 9 Tech = 4 AVO = 0 MPO = 9
                                                      No response = 2
          Who reported most target detections?
Item 3:
          MC = 3 Tech = 0 AVO = 1 MPO = 9 No response = 11
                  Rank order importance of each crewman for target detection.
                   (1.0 most important; 4.0 least important)
                        Mean = 2.0 \text{ SD} = 0.0
                  MC
                  Tech Mean = 3.4 SD = 0.6
                  AVO
                       Mean = 3.4 \text{ SD} = 0.6
                        Mean = 1.0 \text{ SD} = 0.2
                  MPO
        Item 5:
                  Who was unnecessary for target detection?
                  MC = 0 Tech = 7 AVO = 0 MPO = 0 No one = 17
                  Rank order importance of each crewman for target recognition.
        Item 6:
                  (1.0 most important; 4.0 least important)
                        Mean = 2.0 \text{ SD} = 0.0
                  Tech Mean = 3.4 SD = 0.6
                  AVO
                        Mean = 3.4 SD = 0.6
                  MPO
                      Mean = 1.0 SD = 0.2
       Item 7:
                  Who was unnecessary for target recognition?
                  MC = 0 Tech = 8 AVO = 0 MPO = 0 No one = 16
       Item 8:
                  Rank order importance of each crewman for overall mission success.
                  (1.0 most important; 4.0 least important)
                        Mean = 1.4 SD = 0.7
                  MC
                  Tech Mean = 2.6 SD = 1.1
                  AVO
                        Mean = 3.0 \text{ SD} = 0.7
                  MPO Mean = 3.0 \text{ SD} = 0.9
```

13

MC = 0 Tech = 4 AVO = 0 MPO = 0 No one = 20

Who was unnecessary for overall mission success?

Item 9:

```
Compare workload of normal flights with latest flight.
Item 10:
           (1.0 not busy at all; 10.0 very busy)
           Normal Mission Mean = 7.7 SD = 2.7
           Latest Mission
                            Mean = 4.5
                                         SD = 0.9
           Perform own tasks / Perform other crew members' tasks.
Item 11:
           (1.0 = Totally own tasks; 10.0 = Totally others tasks)
           Mean = 1.6 SD = 0.9
CREW C
Item 1:
           Did you look for targets?
           No = 0 Yes = 20
Item 2:
           Who reported the first target detection?
           MC = 0 Tech = 7 AVO = 6 MPO = 7 No response = 0
Item 3:
           Who reported most target detections?
           MC = 0 Tech = 6 AVO = 2 MPO = 12
                                                      No response = 0
Item 4:
           Rank order importance of each crewman for target detection.
           (1.0 most important; 4.0 least important)
                 Mean = 2.9 SD = 0.9
           Tech Mean = 2.9 SD = 1.2
           AVO Mean = 2.8 \text{ SD} = 0.6
           MPO
                Mean = 1.3 \text{ SD} = 0.7
Item 5:
           Who was unnecessary for target detection?
           MC = 8 Tech = 2 AVO = 0 MPO = 0 No one = 10
Item 6:
          Rank order importance of each crewman for target recognition.
           (1.0 most important; 4.0 least important)
                Mean = 2.4 \text{ SD} = 1.3
          Tech Mean = 2.8 \text{ SD} = 1.2
           AVO
                Mean = 2.8 SD = 0.7
                Mean = 1.8 \text{ SD} = 0.8
          MPO
Item 7:
          Who was unnecessary for target recognition?
          MC = 6 Tech = 5 AVO = 3 MPO = 0 No one = 6
Item 8:
          Rank order importance of each crewman for overall mission success.
          (1.0 most important; 4.0 least important)
          MC
                Mean = 3.1 \text{ SD} = 1.4
          Tech Mean = 1.5 SD = 0.6
```

Item 9: Who was unnecessary for overall mission success?

MC = 10 Tech = 0 AVO = 0 MPO = 0 No one = 10

Mean = 3.1 SD = 0.6

MPO Mean = 2.3 SD = 0.7

AVO

```
Item 10:
           Compare workload of normal flights with latest flight.
           (1.0 not busy at all; 10.0 very busy)
           Normal Mission Mean = 9.1 SD = 1.2
                          Mean = 3.7 SD = 2.5
           Latest Mission
           Perform own tasks / Perform other crew members' tasks.
           (1.0 = Totally own tasks; 10.0 = Totally others tasks)
           Mean = 2.9 SD = 1.8
CREW D
Item 1:
           Did you look for targets?
           No = 0 Yes = 24
Item
     2:
           Who reported the first target detection?
           MC = 2 Tech = 8 AVO = 2 MPO = 12
                                                      No response = 0
Item 3:
           Who reported most target detections?
           MC = 0 Tech = 2 AV0 = 0 MP0 = 21
                                                      No response = 1
Item
           Rank order importance of each crewman for target detection.
      4:
           (1.0 most important; 4.0 least important)
           MC
                 Mean = 3.3 \text{ SD} = 0.6
           Tech Mean = 3.4 \text{ SD} = 0.8
           AVO
                Mean = 2.1 SD = 0.5
           MPO
                Mean = 1.0 \text{ SD} = 0.2
Item 5:
           Who was unnecessary for target detection?
          MC = 3 Tech = 12
                               AVO = 0 MPO = 0 No one = 9
Item 6:
          Rank order importance of each crewman for target recognition.
           (1.0 most important; 4.0 least important)
          MC
                Mean = 2.4 \text{ SD} = 1.3
           Tech Mean = 2.8 SD = 1.2
                Mean = 2.8 \text{ SD} = 0.7
           AVO
          MPO
                Mean = 1.8 SD = 0.8
          Who was unnecessary for target recognition?
          MC = 1 Tech = 13 AVO = 0 MPO = 0 No one = 10
Item 8:
          Rank order importance of each crewman for overall mission success.
          (1.0 most important; 4.0 least important)
          MC
                Mean = 3.3 \text{ SD} = 0.5
          Tech Mean = 3.6 SD = 0.6
          AVO
                Mean = 1.5 SD = 0.5
```

Item 9: Who was unnecessary for overall mission success?
MC = 1 Tech = 14 AVO = 0 MPO = 0 No one = 9

Mean = 1.7 SD = 0.8

MPO

III: Post-Test Questionnaire

At the end of the test all crewmen attended an ARI debriefing and completed the questionnaire found in Appendix B. In all, 17 post-test questionnaires were completed. The respondents were instructed to complete the questionnaire as it pertained to their overall experience of the GCS.

Descriptive statistics are shown below, with brief item explanations. (The exact wording of each item is presented in Appendix B.) The data for items one through nine are given for (1) all crew members together, on pages 11 & 12; then for (2) each position, on pages 13-15; then for (3) each crew, on pages 15-17. The responses to items 10 & 11 are summarized on pages 18-21.

ALL CREW MEMBERS

- Item 1: Frequency of equipment obstruction in GCS.
 (1.0 = Never; 10.0 = All the time)
 Mean = 5.4 SD = 2.5
- Item 3: Equipment which obstructs. (Equipment which two or more respondents listed as obstructions.)

Radio rack 13 Teleprinter 6 Chairs Chemical warning box 4 Headset cables 3 NDU plotting arm 3 People Cover on lights 2 Cabinet over plotting table

Interferes with movement in GCS 9
Slows mission performance 4
Headset cables obscure console displays and controls 2

- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 3.7 SD = 2.1

- Item 7: Commo net congestion due to fourth man. $(1.0 = \text{very much}; \quad 10.0 = \text{none})$ $\text{Mean} = 7.2 \quad \backslash \text{SD} = 2.6$
- Item 8: Respondent Comments. Nine comments indicated that having a fourth crewman was helpful in handling communications. Three comments indicated that record keeping was helped. Two comments indicated that it helped in GMD operations.
- Item 10: See pages 18 & 19.
- Item 11: See pages 20 & 21.
- Item 12: No usable data were obtained.
- Item 13: No usable data were obtained.

MISSION COMMANDER

- Item 1: Frequency of equipment obstruction in GCS.
 (1.0 = Never; 10.0 = All the time)
 Mean = 5.0 SD = 2.7
- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 4.0 SD = 1.4

TECHNICIAN

- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 3.0 SD = 2.4

- Item 9: Overlap of Mission commander and Technician duties.
 (1.0 = none; 10.0 = very much)
 Mean = 6.3 SD = 3.0

AIR VEHICLE OPERATOR

- Item 2: Severity of equipment obstruction.
 (1.0 = None; 10.0 = Very much)
 Mean = 3.0 SD = 0.8
- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 5.8 SD = 2.2
- Item 7: Commo net congestion due to fourth man.
 (1.0 = very much; 10.0 = none)
 Mean = 5.5 SD = 3.5

MISSION PAYLOAD OPERATOR

- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 2.4 SD = 1.1
- Item 7: Commo net congestion due to fourth man.
 (1.0 = very much; 10.0 = none)
 Mean = 7.4 SD = 2.8

CREW A

- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 3.4 SD = 3.0

CREW B

- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 2.5 SD = 1.3

- Item 9: Overlap of Mission commander and Technician duties.
 (1.0 = none; 10.0 = very much)
 Mean = 6.5 SD = 2.6

CREW C

- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 ≈ spacious)
 Mean = 5.0 SD = 1.8

CREW D

- Item 1: Frequency of equipment obstruction in GCS.
 (1.0 = Never; 10.0 = All the time)
 Mean = 4.8 SD = 2.2
- Item 5: Crowdedness of GCS.
 (1.0 = crowded; 10.0 = spacious)
 Mean = 4.0 SD = 1.4

- Item 9: Overlap of Mission commander and Technician duties. (1.0 = none; 10.0 = very much) Mean = 6.3 SD = 2.2

The following pages summarize the responses to items 10 and 11, in which the crewmen listed their duties during: (1) mission planning and (2) mission flight. Items for which the duties of the MC and the TC overlap are displayed in **bold** type for emphasis.

Reference: Duties listed in Item 10 (Mission Planning)

- 1. Supervise mission planning process
- 2. Receive mission order from TOC
- 3. Deconflict mission order with TOC
- 4. Brief crew on mission order (including enemy situation, etc.)
- 5. Prepare situation overlay
- 6. Evaluate weather conditions / Gather weather data
- 7. Perform map reconnaissance
- 8. Plan waypoints
- 9. Prepare mission planning worksheet
- 10. Prepare target/search file worksheet
- 11. Enter mission plan and other data
- 12. Verify mission plan
- 13. Plot plan on VDU
- 14. Coordinate AV handoff
- 15. Advise MC on probability of mission accomplishment
- 16. Outline how to fly mission

Table 1. Crew responses to Item 10

Item	MC	TC	AVO	MPO
1	B D	CD	С	
2	ABCD	C		
3	ABCD	BC	D	
4	ABCD	BC		
5	BD	AC	D	ABD
6	AC	BC	BD	AB
7	ABCD	C	D	
8	AB	BC	D	BCD
9	AB	BC	D	
10	AB	BC	D	
11			ABD	CD
12	ABC	BC	AB	А
13		В	В	ABCD
14	В		AD	
15		BD		
16	С			

Table 1 displays crew reports of their Aquila duties during mission planning. For example, for item 1 "Supervise mission planning process", MC's from crews B&D, TC's from crews C&D and the AVO from crew C, all reported that this was part of their Aquila duties during mission planning.

Reference: Duties listed in Item 11 (Mission Flight)

- 1. Activate and check system
- 2. Supervise overall mission
- 3. Operate AVO console
- 4. Operate MPO console
- 5. Operate MC console
- 6. Search for targets and DRL
- 7. Maintain flight/duty log
- 8. Coordinate GCS crew activities
- 9. Coordinate RPV section activities
- 10. Maintain communications with TOC
- 11. Lead post-flight debriefing
- 12. Shut down system
- 13. Set up / monitor MIM
- 14. Communicate with flight operations
- 15. Operate air conditioners
- 16. Monitor power supply
- 17. Ensure tactical doctrine and commander's intent
- 18. Monitor AV status at VDU
- 19. Advise MC
- 20. Plot direct targets
- 21. Launch, handoff, and recover AV

Table 2. Crew responses to Item 11

Item	MC	TC	AVO	MPO
1			BD	ACD
2	ABC	CD		
3		BC	ABD	
4			D	ACD
5	AB D	D	D	
6	ABC	ABCD	BD	ABCD
7		ABD	D	
8	ABC	CD		
9	В	D	Đ	
10	ABCD	ABD	ABD	ABD
11	AB			
12			BD	ACD
13		8	Α	C
14			Α	
15				Α
16				Α
17	В			
18		В		
19		В		
20		В		
21		C	BCD	

Table 2 displays crew reports of their Aquila duties during mission flight. For example, for item 1 "Activate and check out systems", AVO's from crews B&D, and MPO's from crews A,C&D reported that this was part of their Aquila duties during mission flights.

IV: Summary

A: Primary results from the post-flight questionnaire, which was administered at the end of each flight, are as follows:

ALL CREW MEMBERS COMBINED

- (1) As expected, although all crewmen reported looking for targets, the crews reported that the mission payload operator (MPO) detected the most targets and was usually the first to detect a target.
- (2) The GCS crews rated the MPO the most important crewman for target detection and recognition.
- (3) No crew members considered the MPO unnecessary for target detection, target recognition, or overall mission success.
- (4) Essentially, no crew members considered the air vehicle operator (AVO) unnecessary for target detection or mission success.
- (5) 16%, 11% and 13% of the crew responses rated the mission commander unnecessary for target detection, target recognition and mission success, respectively.
- (6) 37%, 42% and 29% of the crew responses rated the technician unnecessary for target detection, target recognition and mission success, respectively. target detection, recognition, or mission success.
- (7) The crew members reported that their workload during FDT&E flights was lighter than during regular flights.
- (8) The crewmen reported that they usually performed their own tasks during a mission. However, there was no consistent pattern across crews concerning the allocation of tasks during flights. In particular, the MC and TC tasks varied greatly between crews. (See post-test questionnaire results on pp 19 & 20.)

MISSION COMMANDERS

- (1) The MC's rated the TC unnecessary for mission success on 50% of the missions.
- (2) The MC's rated themselves unnecessary for mission success on only 5% of the missions.

TECHNICIANS

(1) The TC's rated themselves unnecessary for target detection on 64% of the missions.

- (2) The TC's rated themselves unnecessary for target recognition on 45% of the missions.
- (3) The TC's indicated that only on 10% of the missions had they or the MC's been unnecessary for mission success.

AIR VEHICLE OPERATORS and MISSION PAYLOAD OPERATORS

- (1) The AVO's and MPO's indicated that the MC was unnecessary for mission success on 25% of the missions.
- (2) The AVO's and MPO's indicated that the TC was unnecessary for mission success on 36% of the missions.

CREW DIFFERENCES

Three crews (A,B, & D) seldom, or never, found the MC unnecessary for mission success. However, 50% of the post-flight debriefs for crew C found the MC unnecessary for mission success.

In crews A & D (in which NCO's served as technicians) over 40% of the debriefs found the TC unnecessary for mission success. For crews B & C (in which warrant officers served as technicians) only 18% of crew B post-flight debriefs, and 0% of crew C post-flight debriefs, found the TC unnecessary for mission success.

RESEARCHER COMMENTS

- (1) Researcher observations seem to indicate that, over all four crews, the degree of leadership displayed by the MC was inversely related to that of the TC.
- (2) The crews' workload during the test flights was not as high as that expected in more realistic scenarios. There were several reasons for this, of course. One reason was the AVO's lack of duties during the flights. In any case, one must be cautious in generalizing results from the FDTE to Aquila operations in more realistic situations.

- B: The post-test questionnaire (Appendix B) and debriefing interviews provided the basis for the following observations.
- (1) The GCS with a four man crew is reported to be somewhat crowded.
- (2) The TC is subjected to unnecessary fatigue due to the lack of seating.
- (3) When asked to list their duties, during mission planning and mission flight, there is considerable variation across and among crews concerning how they perceive their tasks to be allocated. The most notable observation, perhaps, is that the NCO's who served as technicians (crews A & D) reported having few tasks during mission planning (Table 1, p 19), while warrant officers (crews B & C) who served as technicians reported having many of the same tasks as the MC's. This finding was not so salient for the mission flights (Table 2 p 21).

Researcher comments

All GCS crewmen should be provided adequate seating. The present arrangements made for the TC's are inadequate.

Attention needs to be given to differentiating MC and TC duties, especially in the light of the MC's greater tactical knowledge, the TC's greater technical knowledge, and the expectation for the Aquila RPV battery to operate 24 hours per day.

APPENDIX A: Post-Flight Questionnaire

We are investigating the effect of crew size on the success of the mission. Your responses will influence decisions that will be made concerning the organization of the GCS crews when this system is fielded. It is, therefore, important that you respond thoughtfully and forthrightly. Your responses will be held confidential, and will not be attributed to you as an individual. Answer the following items as they pertain ONLY to the mission you have most recently completed.

GCS cr	EM	Flight	number _			Dat	:e		a Para rasha kirawana a kabina
Positi	on: MC Tech	AV0	MPO	SSN	(last	four)			ł
(1).	Did you look for during the flight	targets ?				Yes _		No	
(2).	Which crew member the first target	report: detectio	ed on?			MC	Tech	AV0	MPO
(3).	Which crew member most target detec	(s) repo	orted			MC	Tech	AV0	MPO
(4).	Using a 1 for mosfor second and so importance of each target detection.	on, ran	ık the			MC	Tech	AV0	MPO
(5).	Check any crew mer unnecessary for <u>ta</u>	nbers wh arget de	o were			MC	Tech	AV0	MPO
(6).	Using a 1 for most for second and so importance of each target recognition	on, ran orew m	k the	ŗ-		MC	Tech	AV0	MP0
(7).	Check any crew men unnecessary for <u>t</u> a			<u>1</u> .		MC	Tech	AV0	MP0
(8).	Using a 1 for most for second and so importance of each the overall success	on, ran crew m	k the ember to	<u>)</u> .		MC	Tech	AV0	MPO
(9).	Check any crew men unnecessary to the of the mission?			<u>E</u>		MC	Tech	AV0	MPO

Compare how busy you would be during a <u>normal mission</u> (i.e., when the RPV battery flies a mission) to how busy you were during your <u>last mission</u> (i.e., when only the GCS crew were involved).
NORMAL MISSION 12345678910 not busy at all very busy
LAST MISSION 12345678910 not busy at all very busy
Comment below on any differences between your answers to A and B.
Indicate the extent 12345678910 to which you worked totally on totally on on your tasks and on my tasks other crew members tasks.
List the tasks you were <u>assigned</u> on the last mission.
List the tasks you <u>performed</u> on the last mission.

APPENDIX B: Post-Test Questionnaire

GCS	CLEM	Date//
Posi	tion: MC Tech AVO MPO	
[1]	ALL: How often does the equipment physically get in your way?	12345678910 never all the time
[2]	ALL: How severely does this physical interference lower mission performance?	12345678910 not at very all much
[3]	ALL: List the specific equipm	ent which gets in your way.
[4]	ALL: Explain how equipment in	terference lowers mission performance.
[5]	ALL: How crowded are the GCS working conditions?	12345678910 crowded spacious
[6]	TECH ONLY: How fatigued are you by the lack of seating?	12345678910 very fatigued not at all
[7]	ALL: To what extent does the fourth man increase commo net congestion?	12345678910 very much not at all

[8a]	ALL: How has adding a fourth crew member affected mission performance?	i23. lowers a lot	4567 no effect	8910 helps a lot
[8b]	ALL: If it helps, on what tas	ks does it hel	p?	
[9]	ALL: To what degree do the duties of the MC and the technician overlap?	123. not at all	4567	8910 very much
[10]	ALL: Describe in full your du list as a general refere	ties in planni nce).	ng a mission (use	attached
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Describe in full your duties in flying a mission (use attached list as a general reference).

(11) ALL:

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